1997 WATER QUALITY IMPLEMENTATION REPORT

Deer Creek and Jordanelle Reservoirs
Water Quality Management Plan
for the
1996 Water Year

Prepared for:

The Wasatch County Commission

In Association With:

Jordanelle Reservoir
Water Quality Technical Advisory Committee

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which have provided information to this report:

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FINAL REPORT

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CHAPTER ONE

INTRODUCTION

BACKGROUND

The Water Quality Management Plan for Deer Creek and Jordanelle Reservoirs was formulated by the Jordanelle Reservoir Water Quality Technical Advisory Committee (JTAC) in 1984. The Plan was initiated because of the decline of water quality in Deer Creek Reservoir and the projection of poor water quality in the proposed Jordanelle Reservoir. As dictated by the Plan, a water sampling program was implemented by local agencies with results reported on a yearly basis in a Water Quality Implementation Report. This report is written to fulfill this requirement for the 1996 water year.

JTAC consists of representatives from over twenty Federal, State, local and private organizations, who are involved with land use or water resource management within the Provo River drainage. JTAC provides technical assistance to these agencies in accordance with the Water Quality Management Plan. The yearly Water Quality Implementation Reports help provide an analysis of water quality conditions and correlates these conditions to current land uses.

PURPOSE AND SCOPE

The purpose of this report is to document water quality monitoring efforts and analyses performed for the 1996 water year. This report presents the water quality conditions, and updates the water quality trends in the Provo River drainage by drawing correlations between the water quality conditions and the current land use practices.

The specific objectives of this report are:

1. Analyze the water monitoring data for the 1996 water year and present it in a usable form.
2. Document current activities (land use) in the watershed.
3. Document water quality trends within the watershed.
4. Identify areas of water quality concern in the watershed and recommend methods for solving these problems.
5. Show the progress made toward fulfilling the goals of the 1984 Water Quality Management Plan.

AUTHORIZATION

Eckhoff, Watson and Preator Engineering was retained by the Wasatch County Commission, as authorized by JTAC, to prepare the 1997 Water Quality Implementation Report based on data from the 1996 water year.

SOURCE OF DATA

This report documents the 1996 sampling locations and the analyses performed on samples obtained. All laboratory analyses for the JTAC monitoring program were performed by the Utah Department of Health Laboratories. Water quality data used in this report was supplied by the Central Utah Water Conservancy District (CUWCD) and the State of Utah, Department of Environmental Quality, Division of Water Quality (DWQ). Stream flow information was obtained from the U.S. Bureau of Reclamation (USBR), U.S. Geological Survey (USGS), Central Utah Water Conservancy District (CUWCD), and the Provo River Water Users Association (PRWUA). Sampling data for water years prior to 1996 were extracted from previously published Water Quality Implementation Reports and/or from the DWQ.

CHAPTER TWO

CURRENT WATER QUALITY RELATED ACTIVITIES IN THE WATERSHED

INTRODUCTION

The purpose of this chapter is to briefly identify current users of water from the Provo River and to summarize the current activities which could have an impact on, or are related, to water quality within the watershed. In addition, this chapter will identify the progress that has been made towards fulfilling the original goals set in the 1984 Deer Creek and Proposed Jordanelle Reservoir Water Quality Management Plan.

CURRENT WATER USERS

Municipal

The Central Utah Water Conservancy District (CUWCD), the Salt Lake County Water Conservancy District (SLCWCD), the Metropolitan Water District of Salt Lake City (MWDSLC), Orem City and Provo City treat water from the Provo River to provide culinary water for municipal purposes. Water is transported through several diversions below Deer Creek Reservoir to various water treatment facilities in Utah and Salt Lake Counties. There, the water is treated and released for public use.

Agricultural

The Provo River Water Users Association (PRWUA) and the irrigation companies of Salt Lake, Utah and Heber Valleys have rights to Provo River water for agricultural uses. The PRWUA consists of several entities which have rights to the water based on their participation in the construction of the Deer Creek Dam. Fourteen irrigation companies currently operate in Heber Valley.

CURRENT ACTIVITIES

Jordanelle Reservoir

Jordanelle Reservoir filled for the first time on June 11, 1996. During the year, withdrawals were made to meet requirements of the operating agreement including M&I water for Salt Lake County. The Selective Level Outlet Works (SLOW) was operated for the first time in 1996 and a plan for operating the SLOW tower will be

published in 1997 by the operating entity. The SLOW tower will be discussed in more detail below. Toward the end of 1996 and in the beginning of 1997, a significant amount of water was released to allow for expected large spring runoffs during the 1997 water year.

Jordanelle Dam SLOW tower

In 1996, the Selective Level Outlet Works (SLOW) tower was operated for the first time at Jordanelle Dam. One of the objects of the SLOW tower is to reduce total phosphorus (TP) inputs into Deer Creek Reservoir by approximately 25%. This is to be accomplished by a TP retention of approximately 50% in Jordanelle Reservoir. In 1996, Jordanelle TP retention of the Provo River inflow was 47%. With the reduction of the original sources identified in Jordanelle Reservoir Basin the retention would exceed the original goal established in the 1983 plan. However, Jordanelle is a newly filled reservoir, with soils and vegetation inundated for the first time. These soils and vegetation will continue to be significant sources of nutrients for another 3-7 years. Therefore, Jordanelle is expected to discharge higher dissolved phosphorus (2872 Kg - 1996) than the inflow (>2729 Kg from Provo River at Hailstone in 1996) for some time into the future.

The SLOW tower was operated to discharge water temperatures between 48 and 55 F from as early as possible in the spring until as late as possible in the fall. Water was mixed from 2 to 3 gate elevations in the epilimnion and metalimnion, with periodic adjustment at 1 to 2 week intervals. Water temperatures below Jordanelle ranged from 48 to 55 °F throughout the summer of 1996. All the temperature, nutrient, chlorophyll and algae data are being evaluated for 1996. A draft SLOW tower operating criteria will be developed by April 1997 for review. Construction activities could delay or temporarily interrupt operation of the SLOW tower at some point in 1997. However, the SLOW tower should operate much the same in 1997 as occurred in 1996. The goals established for operation of the SLOW tower were met in 1996.

Jordanelle has the greatest potential to release high DTP concentrations and loads from late August through November. After Heber Valley irrigation diversions stop in September, the full phosphorus load will be conveyed to the Deer Creek Reservoir. Deer Creek has the greatest potential to respond with blue-green algae blooms from mid September to mid November depending on temperatures. Therefore, with the Jordanelle Dam in operation greater emphasis needs to be placed on nutrient and plankton monitoring in the Provo River, Jordanelle and Deer Creek Reservoirs in September, October, and November. This may require dropping a sampling period in June or July. Greater sampling emphasis is needed from August to October to better determine the best operating procedures for the Jordanelle SLOW tower to produce the greatest benefit to Deer Creek Reservoir.

Jordanelle State Park

Camping, fishing, boating, hiking and other recreational activities are available at the two developed recreation sites of Jordanelle State Park. The Rock Cliff Recreation Site was completed and opened in June of 1994, the Hailstone Recreation Site was completed and opened to the public in late June of 1996. A third potential recreation site at the end of the North Arm, "Ross Creek" is still awaiting development funding.

The Rock Cliff Recreation Site is located at the east end of the reservoir and has accommodations which include a nature center, elevated boardwalk systems, modern restrooms with showers, group-use pavilions, 50 walk-in camping sites, and limited non-motorized trails.

The Hailstone Recreation Site and Jordanelle Reservoir opened its park gates and launch ramps to a deluge of visitors at the end of June 1995. During the first operating season the park staff hosted 250,000 visitors. The 400 acre tract of land located on the west shore of the reservoir provides facilities for 180 camping units, individual powerboat and personal watercraft launching sites, 30 individual day use cabanas, beach house facility, 3 large group use pavilions, playgrounds, Laundromats, visitor center and a convenience store / restaurant.

The perimeter trail system opened in conjunction with the Hailstone facilities. The park now offers 17 miles of trails available for hiking, jogging, mountain biking, equestrian use, and cross-country skiing. A ten mile segment is planned for future development.

The Ross Creek site will be located on the east shore of the north arm of the reservoir. Limited day use access is planned for the Summer of 1997 in the Ross Creek Area. No permanent facilities are being designed at present because of its limited use due to reservoir fluctuation, and because full development cannot proceed until a sewer system is developed and extended to this location.

Deer Creek Resource Management Plan

The Deer Creek Resource Management Plan for project lands at Deer Creek Reservoir was initiated in 1993 by the Bureau of Reclamation. Phase One was completed in late 1993 and included research of existing planning efforts, determination of plan goals and objectives, and public meetings. Phase One scheduled inventory collection necessary to address issues and outlined the procedure to accomplish Phase Two work.

Phase Two tasks involved the development of possible alternatives for management of the resources in the project lands. The draft Environmental Assessment was published

by the USBR and included various possible alternatives with their potential effects upon implementation. Public and agency comments were received and considered by USBR prior to selecting the preferred alternative. After receiving comments on the four proposed alternatives, an additional alternative was created. This fifth alternative resulted primarily from comments from the PRWUA. This new alternative will be open for public review sometime in 1997. The EA and Resource Management Plan is expected to be finalized in mid-1997. For more information contact the Bureau of Reclamation in Provo, UT (801) 379-1000.

Mayflower Development

Mayflower Mountain Resort continues to monitor water quality parameters in the McHenry Canyon drainage area. Mayflower submitted its annual report to Wasatch County on the water quality monitoring. A short summary of that monitoring report is included in Chapter 4 of this report.
The tailings ponds on the mayflower property have not yet been capped. UDOT had previously committed to provide random fill to Mayflower but was unable to supply it. Mayflower is still working to obtain an alternative economic source of random fill in order to complete the project.

In the mean time, Mayflower implemented storm water controls on the tailings ponds in late 1995 to minimize the potential for storm water runoff problems. These controls include drainage swales and detention basins. Mayflower is inspecting and maintaining these controls each year.

US-189 Construction

Construction on the next segment of US-189 from Upper Falls to Wildwood began in the Spring of 1996 and is scheduled to be completed by the end of 1997. Along with this road segment, a haul road was constructed from Wildwood to the fill site near Little Deer Creek for transporting excess materials. Straw bails are being used during construction to aid erosion control efforts. Once the Upper Falls to Wildwood segment of US-189 is completed, the haul road will be re-seeded and no longer used.

Jordanelle Special Service District - Sewer System

The sewer line connecting the Jordanelle Special Service District (JSSD) with the Heber Valley Regional Wastewater Treatment Plant (HVRWTP) was completed up to the Jordanelle State Park Hailstone Site in the summer of 1996. Additional sewer lines and pump stations are scheduled for construction in 1997 to complete services to the west side of the Jordanelle Reservoir basin.

Construction on the Jordanelle Special Service District Sewer System continued during the summer of 1996. Sewer lines were extended from the State Park west to the Deer Crest property and north to the Staghorn property. Construction will continue during the summer of 1997 to provide service to additional properties to the west and north of the reservoir.

Jordanelle Special Service District - Water System

A Draft version of the "Water System Master Plan for Jordanelle Special Service District" was completed by EWP Engineering and presented to the JSSD in January of 1997. Initial plans call for the design of this system to be completed by Spring 1997 and phase I construction to be completed during Summer 1997.

Twin Creeks Wastewater Facilities Plan

Construction of a sewer line to service members of the Twin Creeks Special Service District began in 1996. Phase I was completed during 1996 and provided a gravity sewer line along East Center Street from 600 East to 2400 East. Connection to the existing sewer system was made at 600 East. Phase II construction is planned for the summer of 1997 and will extend the gravity sewer line along E Center Street from 2400 East to 4800 East. Future phases would most likely extend the sewer line with gravity and pressure flow systems up Lake Creek to serve the Timberlakes development.

UPDES Permits

Facilities in the Provo River watershed which are discharging under Utah Pollutant Discharge Elimination System (UPDES) Permits and the renewal dates for their permits are shown below:

Midway Fish Hatchery	February 28, 2000
Kamas Fish Hatchery	February 28, 2000
United Park City Mines	June 30, 1997

Midway Fish Hatchery

The Midway Fish Hatchery is the largest state-operated fish culture station in Utah. Several springs near the site provide water to the hatchery. The Hatchery's discharge permit places specific limitations on Total Suspended Solids (concentration and daily load), Phosphorus (report concentrations and monthly loads, limit annual net load to 626 kg/yr), and pH. Water from the hatchery passes through a series of settling ponds before being discharged to Snake Creek. The UPDES permit does not limit BOD nor

require monitoring. The JTAC 1994 monitoring showed some BOD exceedences, but the 1995 monitoring did not. BOD was only monitored once in 1996 and that result showed 18.5 mg/l which exceeds the limit of 5 mg/l. See Chapter Five of this report for information concerning this year's monitoring at the Midway Fish Hatchery.

The hatchery's UPDES requirement to limit phosphorus (626 kg/yr.) corresponds to a net increase in phosphorus. This allows the hatchery to subtract the in-flowing phosphorus load from their calculations. These limits took affect on April 1, 1995. Based on monthly discharge monitoring reports submitted to the DWQ, the Midway Fish Hatchery contributed an additional 429.8 kg of phosphorus during the 1996 water year. This total increased load is in compliance with their UPDES permit.

The total phosphorus load discharged from the hatchery was calculated at 834 kg (see Appendix C). This load calculation does not subtract for the in-flowing load but can be used to compare with previous implementation reports.

Kamas Fish Hatchery

The Kamas Fish Hatchery is located along Beaver Creek several miles east of the Town of Kamas. A nearby spring serves as the source of water for the facility. The Hatchery has been required to control pollution from the facility by complying with UPDES permits since 1975. The UPDES permit issued to the Kamas Fish Hatchery in 1985 required monitoring of total phosphorus at the intake to and effluent from the hatchery. However, no limits were set for the concentrations or total daily amounts of phosphorus that could be contributed by the hatchery. When the permit was renewed in 1990, the requirement to monitor phosphorus was eliminated. JTAC has been funding the phosphorus monitoring costs at the hatchery since 1990.

In spite of efforts by Wasatch County to persuade the DWQ to reinstate the phosphorus monitoring requirement, when the permit was again renewed in March 1995, the requirement to monitor phosphorus was not included. The current permit is not scheduled to be renewed again until the year 2000.

The Hatchery's current discharge permit places specific limitations on Total Suspended Solids, and pH. The UPDES permit (1990-1995) limited BOD to a daily maximum of 25 mg/l. This requirement is not a part of the current permit (1995-2000). According to the current UPDES Permit for the Kamas Hatchery, Total Dissolved Solids (TDS) limitations are only applicable to those discharges from fish hatcheries within the Colorado River Basin. Therefore, TDS requirements are not applicable to the Kamas Hatchery.

All of the seven samples analyzed for Total Phosphorus in 1996 had results which were

equal to or in exceedence of the JTAC standard of 0.04 mg/l. See Chapter Four of this report for additional information concerning this year's monitoring at the Kamas Fish Hatchery.

The Kamas Fish Hatchery discharges water into Beaver Creek. Most of the flow from Beaver Creek is diverted into the Weber-Provo Canal during spring runoff. During the growing season most of the flow in Beaver Creek is diverted for agricultural purposes. Some of the return flows from the irrigated fields flow into the Weber-Provo Canal.

The Kamas Fish Hatchery is scheduled for reconstruction during 1997 or 1998. Current intentions include lining all ponds with concrete to improve production as well as to decrease food consumption. In addition, settling ponds will be added to help reduce suspended solids and thereby reducing total phosphorus being discharged into Beaver Creek. This reconstruction will include complete demolition and rebuilding of the Kamas Fish Hatchery facilities.

United Park City Mines

United Park City Mines (UPCM) currently has submitted an application to renew their permit to discharge from its treatment facility located at Keetley Station into Drain Tunnel Creek, a tributary of Jordanelle Reservoir. Parameters which are monitored include flow, oil and grease, TSS, copper, lead, mercury, zinc, total hardness and pH. The permit will need to be renewed by June 30, 1997 and according to Division of Water Quality personnel, Aluminum may be added as new constituent.

Wasatch County Water Efficiency Project & Daniels Replacement Project

The Final Draft Environmental Impact Statement (EIS) for the Wasatch County Water Efficiency Project and Daniels Replacement Project (WCWEP&DRP) was completed September 1996. The WCWEP&DRP was authorized by the CUP Completion Act which requires that flows in the upper Strawberry River be restored. This is to be accomplished through the replacement of flows presently diverted to Daniels Creek for the Daniels Irrigation Company with water from the Jordanelle Reservoir via a pipeline that is to be constructed. Additionally, planning efforts for this project include the implementation of water conservation measures such as conversion to sprinkler irrigation and environmental enhancement programs.

In addition, the Provo River Restoration Project (PRRP) EIS is being conducted in conjunction with the WCWEP&DRP EIS discussed above. The Provo River Simulation Model (PROSIM) was used to evaluate alternatives for the studies. The completed EIS for these studies was made available for public comment during 1996. The Final EIS for the WCWEP&DRP was published in November 1996. Design for construction of

facilities in accordance with the EIS is currently underway.

Groundwater Study

The State Water Quality Board classified the aquifer in Heber Valley as Class 1A pristine in 1995. In order to protect the water quality of the aquifer, Wasatch County approved an ordinance requiring developments with a density greater than one residence per five acres to be served by a sewer system prior to approval of the development plan. In addition, Wasatch County is urging JTAC members to to develop a groundwater monitoring plan to help detect any existing or future problems and define trends in the groundwater. This effort can be started by corrolating the available data from existing wells in the valley.

Tri-Valley Watershed Project

The Natural Resources Conservation Service (NRCS), through the United States Department of Agriculture's Small Watershed Program (PL-566), is assisting Wasatch Soil Conservation District and Wasatch County in planning a land treatment watershed. The plan will address natural resource problems and opportunities within the 248,000 acre watershed.

Purposes of the Tri-Valley Watershed are water conservation, improved fish and wildlife habitat, and water quality. The on-farm irrigation systems will fulfill the purpose of water conservation and improved fish and wildlife habitat. The on-farm systems will receive a priority because conserved water will be used to enhance in-stream flows to benefit fish habitat. Some water quality improvements may also result from decreased surface runoff and decreased deep percolation. Other water conservation and water quality projects will be considered in the area as a result of the watershed plan.

Resource inventories necessary for this planning effort have been completed. A draft of one of the watershed resource reports was published by NRCS in September 1996 entitled "Erosion and Sedimentation Resource Evaluation Report on the Main Creek Watershed." This report looks at issues associated with animal waste, human waste, stream bank erosion, and riparian habitat degradation in the Main Creek Watershed.

A draft review of the Watershed Plan / Environmental Assessment is projected for March 1997. This Assessment will incorporate several watersheds throughout the Tri-Valley Area. Initial funding for on-farm watershed treatments will be requested for Fiscal Year 1998. The NRCS is also working with two land owners in Heber Valley to create demonstration Riparian Restoration projects.

Wasatch County Water Quality Management Plan

EWP Engineering began work on the Wasatch County Water Quality Management Plan in 1995. This plan has two main goals. First to correlate various water quality studies of the Provo River Basin in Wasatch County and determine areas where effort must be taken to bring these water courses into compliance with state water quality standards. This effort will include using the EPA's Total Maximum Daily Load (TMDL) method for determining maximum load amounts for the various contaminants causing problems in the basin. The second goal is to develop management strategies for where and how the contaminants in the basin can be reduced. A draft copy of this report is expected to be delivered to JTAC members for review in March 1997.

PROGRESS TOWARDS 1984 GOALS

In 1984, the Deer Creek Reservoir and Proposed Jordanelle Reservoir Water Quality Management Plan was completed by JTAC. The plan determined that an average of approximately 25,000 kg/yr of total phosphorus were entering Deer Creek Reservoir on an annual basis. The plan identified goals for reducing the average phosphorus load by 11,000 kg/yr. Table 2.1 shows the goals made in 1984 and the estimated reductions which have been achieved. Many agencies and groups have spent considerable time and money on water quality, erosion control, and related projects. Table 2.2 includes a partial listing of expenditures on water quality related programs and projects which have occurred within the Deer Creek and Jordanelle Reservoir Watersheds.

TABLE 2.1

PROGRESS TOWARDS 1984 GOALS

1984 Goal	Estimated Average Annual Phosphorus Reduction (kg)
Heber Valley Regional WWTP	5,000
Snake Creek Rural Clean Water Program	1,000
Construct Jordanelle Reservoir	4,800
Dairy and Feedlot Cleanup Projects	1,075
Fish Hatchery Phosphorus Removal	625
Other (erosion control and shoreline improvement projects)	not quantified
Total	12,500

TABLE 2.2

DEER CREEK & JORDANELLE RESERVOIR WATERSHED
RECENT EXPENDITURES ON
WATER QUALITY RELATED PROGRAMS AND PROJECTS

1	ASCS Watershed Projects for Pollution Cleanup	$	62,000
2	CUWCD Provo River Water Quality Monitoring	e	24,600
3	Clean Lakes 314 Project Phase I - Investigation		145,000
4	Clean Lakes 314 Project Phase II - Implementation		416,000
5	Deer Creek & Jordanelle 1985 Implementation Plan		200,000
6	Deer Creek & Jordanelle 1986 Implementation Plan		263,000
7	Deer Creek & Jordanelle 1987 Implementation Plan		141,096
8	Deer Creek & Jordanelle 1988 Implementation Plan		143,036
9	Deer Creek & Jordanelle Water Quality Management Plan		160,000
10	Deer Valley Resort Sediment Detention Basins 1983-85		320,000
11	Deer Valley Resort Water Quality Monitoring	e	94,300
12	Heber Valley Special Service District WWTP		13,600,000
13	Jordanelle Dam Wastewater Control Plant Construction		171,885
14	MAG 205j Water Quality Plan		80,000
15	MAG 208 Areawide Water Quality Management Plan		1,181,000
16	Mayflower Mountain Resort Tailings Investigations		24,567
17	Mayflower Resort Sediment Detention Basin 1988		155,000
18	Mayflower Resort Water Quality Monitoring	e	86,000
19	Midway Fish Hatchery Settling Ponds		70,000
20	SLCoWCD Provo River Water Quality Investigations	e	29,000
21	Snake Creek Rural Clean Water Project 1981-88		754,500
22	Sprinkler Irrigation Systems Installation		3,250,000
23	State Agriculture Contribution to MAG & SCRCWP		30,000
24	State Division of Health 303e Water Quality Plan		200,000
25	State Hazardous Waste Investigation Olson / Neihart		500,000
26	State Parks and Recreation Deer Creek Master Plan		6,700
27	State Water Resources Sprinkler Irrigation Study		25,000
28	UDOT US 189 to Kamas - Sediment Basins		27,024
29	UDOT US 189 to Kamas - Regular Erosion Control		370,275
30	UDOT US 40 North Contract - Sediment Basins		56,648
31	UDOT US 40 North Contract - Regular Erosion Control		904,432
32	UDOT US 40 South Contract - Sediment Basins		98,525
33	UDOT US 40 South Contract - Regular Erosion Control		401,083
34	USBR Jordanelle Outlet Control Structure Design	e	79,000
35	USBR Investigations Olson / Neihart Tailings	e	75,000
36	USGS Groundwater Two Year Study 1987-88		283,600

Table 2.2 (continued)

37	Uinta National Forest Soapstone Erosion Study		7,000
38	Utah Department of Agriculture ARDL Watershed Projects		368,532
39	Utah Department of Agriculture Irrigation Management		10000
40	Wasatch County Route "A" Erosion Control Design		65000
41	Wasatch County Development Plan Review for Water Quality	e	3670
42	Wasatch National Forest Provo River Erosion Study		5000
43	Wasatch National Forest Trial Lake Dike Repairs		158000
44	Taste and Odor Studies - CUWCD	e	25,000
45	Wasatch County water quality planning through MOU with CUWCD	e	195,000
46	Deer Creek Reservoir Water Quality Modeling - CUWCD	e	107,000
47	Periphyton Studies - Provo River - CUWCD	e	27,000
48	Dissolved Oxygen Studies - Lower Provo River - CUWCD	e	12,000
49	Deer Creek & Jordanelle 1988 Implementation Plan		168,000
		Total	$25,411,000

Note: e = estimate

CHAPTER THREE

1996 WATER QUALITY MONITORING PROGRAM

INTRODUCTION

This Chapter provides a description of the JTAC monitoring program and other programs within the watershed and describes the format, standards, methodologies, and assumptions used in presenting the data in subsequent chapters.

JTAC MONITORING PROGRAM

JTAC has directed the Water Quality Monitoring Program for the Jordanelle/Deer Creek Watershed since 1985. The water quality monitoring results are used by JTAC to help locate sources of water quality problems and detect or document water quality trends within the system.

The 1996 monitoring plan is shown in Table 3.1. The locations of the sampling stations are shown on Maps 1-4 included at the end of this chapter.

The DWQ has the task of coordinating the yearly monitoring program. The DWQ provides field sheets to samplers, collects testing results, inputs testing results into the State database, and provides final data in an ASCII text format to the CUWCD. The CUWCD, Mountainland Association of Governments (MAG), and the USBR gathered samples in the field. The CUWCD supplied the data in a spreadsheet format to Wasatch County to use for analysis for the annual implementation report. The data is summarized in Appendix A and included in raw form in Appendix E.

The watershed has been segmented into the following sub-basins to simplify the presentation of data. Please refer to these chapters for specific information concerning that portion of the watershed.

Chapter	*Sub-basin*
4	*The Upper Provo River and the Jordanelle Reservoir Basin* (Includes: Provo River, Kamas Fish Hatchery, Weber-Provo Canal, Jordanelle Reservoir, Drain Tunnel Creek, McHenry Creek)
5	*Heber Valley* (Includes: Provo River, Spring Creek, Lake Creek, Snake Creek, Midway Fish Hatchery)

6 *Deer Creek Reservoir Basin* (Includes: Deer Creek Reservoir, Sagebrush Canal, Lower Charleston Canal, Daniels Creek, Main Creek)

7 *Provo River below Deer Creek Reservoir* (Includes: Provo River, Little Deer Creek, North Fork, South Fork)

These chapters further identify sampling locations, present a summary (in the form of average, median, minimum, maximum and number of samples) of the year's data for each location and highlight those parameter values which exceed the state standard.

For statistical purposes, all values reported as a "less than" figure were converted to zero. (According to "Statistical Methods For Environmental Pollution Monitoring" by Richard O. Gilbert, a measurement less than the limit of detection may be reported as zero.) However, it must be recognized that this strategy implies a bias. For the purposes of this report, the bias is considered insignificant.

The water quality data for the 1996 Water Year is provided in Appendix A. Flow Data is presented in Appendix B. The raw water quality data included in Appendix E shows the values with the corresponding "less than" figure if applicable.

JTAC SAMPLING PROGRAM FOR DISSOLVED METALS

The JTAC sampling program for dissolved metals encompasses the Provo River from Woodland to Olmsted, all major tributaries and both Jordanelle and Deer Creek reservoirs. Results of the 1996 sampling program for dissolved metals are presented in Tables 4.3, 5.3, 6.3, and 7.3 in accordance with the corresponding sub-basin. The raw data is also included in Appendix E.

STREAM AND RESERVOIR CLASSIFICATION

The State of Utah has classified surface waters within its jurisdiction according to beneficial use. The classifications for the principal surface waters within Wasatch County are listed below:

Surface Water	Beneficial Use
Provo River	1C, 2B, 3A, 4
Deer Creek Reservoir	1C, 2A, 2B, 3A, 4
Jordanelle Reservoir	classification pending

where:

Class 1C: Protected for domestic purposes with prior treatment processes as required

by Utah Department of Health.

Class 2A: Protected for primary contact recreation such as swimming.

Class 2B: Protected for boating, water skiing and similar uses, excluding swimming.

Class 3A: Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain

Class 4: Protected for agricultural uses including stock watering and irrigation of crops.

* The State of Utah has not yet adopted the classification for Jordanelle Reservoir. However, it is expected that the classification will be the same as for Deer Creek. For the purposes of evaluating Jordanelle water quality for the 1996 water year, the standards associated with Beneficial Uses 1C, 2A, 2B, 3A, & 4 will be utilized.

WATER QUALITY STANDARDS OR PROBLEM INDICATORS

The State of Utah has established numeric standards for the water quality parameters associated with the different beneficial uses. For additional information regarding the state standards refer to Utah Administrative Code R317-2 Standards of Quality for Waters of the State. The numeric standards which define the designated beneficial uses for the waters within Wasatch County are presented in Table 3.2.

The minimum dissolved oxygen level for aquatic wildlife is 8.0 mg/l during early stages of life and 4.0 mg/l at other times. The DWQ has established the practice of identifying all samples with DO levels less than 6.5 mg/l rather than studying each water site to determine if aquatic wildlife is present in its early stage of life.

The state DO standards are mainly set up for streams and were not intended for deep waters. However, a low DO measurement in reservoirs is still indicative of a water quality problem. For the purpose of this report, the DO measurements below the surface in the Jordanelle and Deer Creek Reservoirs were identified as exceedences when they were below 2.0 mg/l.

The state standard for Phosphate as P is 0.05 mg/l for streams and rivers, and 0.025 mg/l for reservoirs. The 1984 Watershed Management Report by JTAC recommended a maximum allowable Total Phosphorus concentration of 0.04 mg/l for all water entering Deer Creek Reservoir. Therefore, stream samples with P greater than the JTAC standard of 0.04 mg/l were identified as exceedences.

LOADING ANALYSIS

The loading analysis for total phosphorus and total suspended solids (TSS) utilized the time increments that correspond to the dates samples were taken. Parameter concentrations were multiplied by the average daily flow of the sampling date to produce a total loading for that day. Adding this daily loading value to the daily loading value from the previous sampling date and dividing by 2 yields an average daily loading value for the time interval between sampling dates. Multiplying the average daily loading value by the number of days in the interval produces a loading value for the interval. This method best approximates the loading characteristics of the river during the critical high flow season. A statistical report providing additional details and justification for this method of loading calculations was published in the 1992 Implementation Report. Loading calculations using the methods described are presented in Appendix C.

QUALITY ASSURANCE/QUALITY CONTROL

A quality control program was first initiated as a part of the 1991 JTAC monitoring program. It has continued to be a part of the monitoring program with each successive year. The purpose of the program is to check the consistency of the sampling procedures and the laboratory sample analyses. Under this program, each monitoring agency has been assigned one site at which they take two sets of samples. One set is labeled as being from the actual site. The other set is labeled and submitted to the lab as if it had come from another site.

When the sample analysis data is received from the lab, the blind site data is compared to the actual site data. A report analyzing the QA/QC results is produced annually by the DWQ and is included as Appendix D.

TABLE 3.2 STATE OF UTAH - NUMERIC CRITERIA FOR WATER USES

Parameter	*1C Domestic Source*	*2A & 2B Recreation & Aesthetics*	*4 Agriculture*	*3A Aquatic Wildlife*
BACTERIOLOGICAL				
Max. Total Coliform Max. Fecal Coliform	5000 2000	1000 200		
PHYSICAL				
Min. DO (mg/L) pH (Range) Max Temp. (Centigrade)	5.5 6.5-9.0	5.5 6.5-9.0	5.5 6.5-9.0	6.5 (8.0/4.0) 6.5-9.0 20
METALS				(1 hr. avg.)
Arsenic (mg/L) Barium (mg/L) Cadmium (mg/L) Chromium (mg/L) Copper (mg/L) Iron (mg/L) Lead (mg/L) Mercury (mg/L) Selenium (mg/L) Silver (mg/L) Zinc (mg/l)	0.05 1.0 0.01 0.05 0.05 0.002 0.01 0.05		0.1 0.01 0.10 0.2 0.1 0.05	0.36 0.0039 0.016 0.018 1.0 0.082 0.0024 0.02 0.004 0.12
POLLUTION INDICATORS				
BOD (mg/L) Nitrate as N (mg/L) Phosphate as P (mg/L)		5.0 4 0.05/0.025	5.0	5.0 4 0.05/0.025
INORGANICS				
Ammonia as N (mg/L) Dependent on Temperature and pH - See Table 2.14.2 State Rule				

CHAPTER FOUR

THE UPPER PROVO RIVER AND JORDANELLE RESERVOIR BASIN

INTRODUCTION

The Upper Provo River segment begins at the head waters of the Provo River in the Uinta Mountains and ends at the Jordanelle Reservoir. The Upper Provo River was monitored at two locations: one above Woodland at the USGS gauging station and the other 2 1/2 miles above Hailstone. This segment of the Provo River receives supplemental flow from trans-basin diversions via the Duchesne Tunnel and the Weber-Provo Canal. Predominant forms of land use within the basin include summer livestock grazing, wildlife habitat, outdoor recreation, along with seasonal and year-round residential developments.

The Jordanelle Reservoir Basin consists of the Jordanelle Reservoir and tributaries. Land use in the basin will be incurring some significant changes, as numerous large scale developments begin construction in the areas surrounding the reservoir. The state park opened the Hailstone site in 1996 and other developments are expected to be under construction throughout the next many years.

MONITORING DATA

The sampling stations located on the Upper Provo River and the Jordanelle Reservoir Basin which were utilized as part of the 1996 JTAC sampling program are listed below.

Storet Number	Location
499840	Provo River above Woodland @ USGS gage
492900	Kamas Fish Hatchery effluent
499814	Weber-Provo Canal Diversion at US 189
499813	Provo River at Hailstone Junction below Weber Provo Canal
591404	Jordanelle Reservoir - Provo arm
591403	Jordanelle Reservoir - North arm
591401	Jordanelle Reservoir - Above dam
499804	Ontario #2 Drain Tunnel (Park City Ventures)
499767	McHenry Creek below Mayflower

Table 4.1 presents average, median, minimum, and maximum values for water quality parameters which were monitored at each of the individual stations in 1996 within the Upper Provo River Basin and the Jordanelle Reservoir Basin. Table 4.2 presents a

summary of all reported parameters which exceed the state standard. Table 4.3 presents the data obtained from the JTAC dissolved metals sampling.

At the recommendation of the CUWCD, loadings for the Weber-Provo Canal Diversion (See Appendix C) have been calculated using flow data collected at the Provo River Water Users Association (PRWUA) gauge on Highway 189 near Francis rather than the USGS gauge located upstream. This gauge has been used since the 1994 water year. Discrepancies between the gauges have been identified and could lead to inaccurate load calculations. The CUWCD feels that the PRWUA gauge is more accurate and prefers use of that gauge since it is used in the management of water in the Provo River.

THE UPPER PROVO RIVER

The Provo River

The Woodland site reflected good water quality conditions throughout the entire 1996 sampling year. Both suspended solids and total/dissolved phosphorus levels were typical of a year with this level of flow. No exceedences occurred with TSS or Phosphorus. Total phosphorus levels and total suspended solids (TSS) for the Upper Provo River are graphically illustrated in Figures 4.1 and 4.2.

At the Hailstone site, no exceedences were measured for Total Phosphorus. Table 4.4 shows the increases and decreases in total and dissolved phosphorus through the Provo River System from above Woodland to below Deer Creek Dam. Figure 4.3 shows these loadings graphically.

The increase of total phosphorus and TSS between Woodland and Hailstone seems to vary from year to year. The total phosphorus loadings for Woodland and Hailstone and the ratio of total phosphorus at the Hailstone site versus the Woodland site are shown in Table 4.5 for the years 1991 to 1996. The total phosphorus ratio increased from approximately two in 1991 and 1992 to nearly four in 1993 and 1994. In 1995, the ratio was again approximately two, and in 1996 the ratio increased to nearly three.

Table 4.6 identifies the TSS loading for Woodland and Hailstone and the difference between the downstream and the upstream loads for the years 1991 to 1996. The difference in the TSS load has varied significantly over the past five years in terms of mass loading and percent differences between the two sites. The percentage of Hailstone's total phosphorus and TSS loads from above Woodland, below Woodland and the Weber-Provo Canal are shown in Table 4.7. This table shows that in 1996, a relatively high percent of TSS came from the Weber Provo Canal but a higher percent of TP flowed directly into the Provo River between Woodland and Hailstone.

Tributaries

Two of the six Weber Provo Canal samples reached or exceeded the JTAC standard for total P (0.04 mg/l on June 19, 1996, and 0.05 mg/L on September 24, 1996). Although the canal contributed a more water in 1996 when compared with 1995, the phosphorus concentration and load was less (see tables 4.5 and 4.6).

The Kamas Fish Hatchery discharges into Beaver Creek. This discharge was high in Total Phosphorus (seven exceedences from seven samples) and Dissolved Phosphorus (three exceedences from six samples) concentrations. But even though the samples still experienced frequent exceedences, they were not as bad as 1995. In fact the flow weighted average concentration for TP was 0.061 mg/l in 1995 and 0.048 in 1996. During the agricultural growing season, the flow from Beaver Creek is generally used for irrigation, but some return flows enter the Weber-Provo Canal and thereby contribute to the Provo River system.

THE JORDANELLE RESERVOIR BASIN

The Jordanelle Reservoir

The Jordanelle Reservoir was monitored above the dam, in the North Arm, and in the Provo Arm. Monitoring was scheduled to occur on the reservoir during the months of January, February and March. However, due to the difficulties of collecting a sample while varying thicknesses of ice exist on the reservoir, these samples are seldom taken. If a method could be determined to safely take these samples, the winter time data could be important to analyze and monitor over the years.

The reservoir again captured a significant portion of the total phosphorus and TSS loads from the Provo River, and prevented them from moving downstream into Deer Creek Reservoir. The load reduction is mostly related to sedimentation in the reservoir.

The Total Phosphorus and TSS loadings along the Provo River are presented in Figures 4.3 and 4.4. Total phosphorus and dissolved phosphorus loadings along the Provo River for 1996 are also listed in Table 4.4. Similar to previous years, a significant amount of total phosphorus and suspended solids was retained in Jordanelle Reservoir. However, most of the phosphorus retained was in sediment form. For example, approximately half of the 5852 kg of total phosphorus at the Hailstone site was dissolved but almost all of the 3072 kg of total phosphorus below the dam was dissolved. Unlike 1995, when the dissolved phosphorus load more than doubled between these two sites, during 1996, the dissolved phosphorus load remained about the same between Hailstone and below the Jordanelle dam. It is possible that this

improvement may be related to operation of the SLOW tower. The dissolved phosphorus is the portion of the total phosphorus which is organically available for immediate uptake by aquatic plants and algae.

On an annual basis the Jordanelle reservoir reduces the total annual nutrient loading to Deer Creek as a result of sedimentation within Jordanelle. Some nutrient loadings typically come from within a reservoir during the initial period of basin filling and nutrient leaching from inundated soils. The long term effectiveness of actual nutrient reductions to Deer Creek will be based on the operation of Jordanelle discharges as well as the amount of dissolved nutrients which are not removed by Jordanelle.

With the filling of Jordanelle Reservoir, depleted oxygen levels have been of concern in past years especially in the north arm of the reservoir. The water quality seems to have improved in the north arm. None of the samples taken in the north arm exceeded the JTAC or state standard and only one exceedence for dissolved oxygen (DO) content occurred in the Jordanelle Reservoir during the 1996 sampling year. In 1995 the mean DO content for the north arm was 4.5 mg/L for the bottom layer whereas in 1996 the DO content had increased to 6.0 mg/L for the same location.

All of the reservoir monitoring sites displayed total phosphorus concentrations in the bottom levels which were above the standard of 0.025 mg/L. The north arm had nine exceedences, the Provo arm had two exceedences and the site above the dam had six samples beyond the limit. The north arm may have more exceedences due to its lower DO content than the other two sampling sites. The DO for the north arm, bottom layer may have improved from 1995 (4.5 to 6.0 mg/L), but the DO content is still lower than the values for the Provo arm (6.5 mg/L) and the site above the dam (7.3 mg/L). During lower DO periods phosphorus which is bound to bottom sediments can be released back into the water column.

Profile data for temperature, dissolved oxygen, specific conductance, redox potential, and pH were collected on Jordanelle Reservoir at the time of sampling. Temperature and dissolved oxygen profiles for the summer months of May to August at the three sampling sites are shown in Figures 4.5, 4.6 and 4.7. The profiles show the slight overall decrease in DO concentrations in the north arm compared to the site above the dam and the Provo arm. As mentioned above, the most extreme case of oxygen depletion occurred in the North Arm. The temperature profiles are similar for all three sampling locations. All three sites exceed the temperature standard during July and August.

The movement of water through the Provo Arm of the reservoir may attribute for the higher oxygen levels in the Provo Arm and above the dam. The water from the Provo River moves through the reservoir and provides some mixing. This is illustrated in the profiles as the dissolved oxygen levels begin to rise in the waters below the thermocline

at the site in the Provo arm. In the North Arm, the lack of a major inflow comparable to the Provo River contributes to the stratification and lowered DO concentrations due to lack of mixing. Figure 4.8 shows the Dissolved Oxygen levels from the bottom layer at the three sites through the summer months.

The Carlson Trophic State Index (TSI) has been used by the State of Utah to rank and compare the trophic status of lakes and reservoirs within the state. Throughout the state, data has been used during the months from May to September for determining the TSI values. The September sampling event did not occur during 1996 so the months of May through August were used to determine the trophic state index. The state averages the TSI values obtained from Secchi disk transparency, total phosphorus and Chlorophyll A to calculate an overall TSI for the reservoir. Table 4.8 shows the calculation of the TSI values for all three stations on Jordanelle. The average of all three sites was 43 which indicates a mesotrophic status.

Phytoplankton Floras from Jordanelle Reservoir

Annual phytoplankton studies are conducted on Jordanelle Reservoir as well as on Deer Creek Reservoir. Samuel R. Rushforth, a Professor of Botany at Brigham Young University, has been completing these studies.

This year's study is not yet available but the abstract will be included as a summary in the final report.

Tributaries

In addition to the Provo River, the two principal tributaries to Jordanelle Reservoir included in the 1996 monitoring program are McHenry Creek and Drain Tunnel Creek.

McHenry Creek had a relatively high concentration of phosphorus on May 6 and 23, 1996 (0.05 mg/l for both dates). The dissolved phosphorus loadings were low at 0.02 mg/l for both days suggesting that much of this loading was sediment related. This is further supported by the high TSS values of 20 mg/L and 17.6 mg/L, respectively.

The main source of water for Drain Tunnel Creek is the Park City Ventures Mine - Ontario #2 Drain Tunnel. Drain Tunnel Creek receives water originating in mine shafts under the Park City area and conveyed to the Jordanelle Basin through a tunnel. Phosphorus concentrations in the Drain Tunnel Creek did not exceed the state pollution indicator in 1996. However, the pH level exceeded the limit during four of the seven sampling events.

Monitoring by Mayflower Resort

Mayflower Mountain Resort has been responsible for a monitoring program since 1984. The program has been governed by agreements with Wasatch County since 1985. Mayflower provides analysis of water quality in an annual report to Wasatch County.

The two sites monitored by Mayflower Mountain Resort are both on McHenry Creek. Site A is located at the outlet works of the Utah Department of Transportation and Mayflower Mountain Resort's Detention Basin, located east of U.S. 40. Site 1 is located on the west side of U.S. 40 on McHenry Creek.

The monitoring included weekly water quality sampling at both sites during the spring runoff (April 23 - June 9, 1996). The samples were tested for TKN (Total Kjeldahl Nitrogen), Total Phosphate, Ortho Phosphate, TSS (Total Suspended Solids), and pH. During 1996, the recording device used to record flow measurements at site A malfunctioned and no flow data was recorded. Therefore, flow data is only available at site 1.

The 1996 report from the Mayflower Mountain Resort includes the following summary (for more details concerning the Mayflower monitoring please refer directly to the annual report):

> It was unfortunate that the data logger on Station "A" malfunctioned. There is no record of flow from that station for the 1995-1996 season. There was a considerable amount of snow during the winter. Snow did not come until after mid December. The runoff started within a few weeks of previous years. The beavers that used to inhabit the lower portion of McHenry Creek have moved up above Station #1. There was a very large beaver dam just prior to the stream gage. The beavers will have an effect on water quality in the drainage.
>
> There was no construction above the monitoring Stations during the 1995-1996 season. There could be minor construction at Deer Valley. That construction activity would be picked up in their water monitoring.
>
> There was construction during the summer by the Jordanelle Sewer District. They have been installing sewer lines that will feed Mayflower and other property owners in the Jordanelle basin.

A summary of loadings and peak measurements at the two monitoring sites is as follows:

	LOADS			PEAK MEASUREMENTS		
		A	1		A	1
Runoff	(ac-ft)	n/a	261.3	(cfs)	n/a	6.41
TKN	(kg)	n/a	298.8	(mg/l)	1.8	1.6
Total P	(kg)	n/a	37.6	(mg/l)	0.16	0.41
Ortho P	(kg)	n/a	12.1	(mg/l)	0.05	0.05
TSS	(kg)	n/a	19467	(mg/l)	65	298

Note: Loads could not be calculated at Site A because flow data was not available.

Monitoring by Deer Valley Resort

Deer Valley Ski Resort has followed an agreement with Wasatch County to implement erosion control measures intended to minimize contamination of streams due to ski area development. As part of the agreement, the Resort has also conducted a water quality monitoring program since the spring of 1989. Deer Valley provides water quality analysis in an annual report to Wasatch County. The 1996 report from the Deer Valley Resort Company has not yet been received. The executive summary will be included in the final printing of this report.

Some Construction occurred in 1996 to install a few snow making lines. These were installed in areas already draining to the existing sediment ponds. Deer Valley completed the work during the construction season and reseeded the disturbance before lasting snowfall. EWP visited the site before and after construction and observed good BMP's in place.

TABLE 4.4

PROVO RIVER TOTAL AND DISSOLVED PHOSPHORUS LOADINGS

Location	Total P (kg)	Dissolved P (kg)	Dissolved P % of Total
Woodland	2033	988	49
Hailstone	5852	2729	47
Below Jordanelle Dam	3072	2872	93
Above Deer Creek Res.	8566	4729	55
Below Deer Creek Dam	8002	6081	76

TABLE 4.5

TOTAL PHOSPHORUS LOADINGS FOR WOODLAND AND HAILSTONE, 1991-1996

Year	(1) Woodland Total P (kg)	(2) Hailstone Total P (kg)	(3) Hailstone vs. Woodland Total P Ratio (2) / (1)
1991	3,413	6,012	1.76
1992	1,812	3,883	2.14
1993	6,118	23,096	3.78
1994	2,122	7,946	3.74
1995	6,878	14,124	2.05
1996	2033	5852	2.88

TABLE 4.6

TSS LOADINGS FOR WOODLAND AND HAILSTONE, 1991-1996

Year	(1) Woodland TSS (kg)	(2) Hailstone TSS (kg)	(3) Hailstone vs. Woodland Delta TSS (2) - (1)
1991	8,783,072	9,372,677	589,605
1992	235,101	617,156	382,055
1993	7,693,845	15,266,237	7,572,392
1994	1,716,324	8,245,837	6,529,513
1995	10,334,714	14,552,043	4,217,329
1996	2,486,544	5,595,323	3,108,779

TABLE 4.7

HAILSTONE TOTAL PHOSPHORUS AND TSS LOADS, 1993-1996

	1994		1995		1996	
Location	Percent of Hailstone Total P Load (%)	Percent of Hailstone TSS Load (%)	Percent of Hailstone Total P Load (%)	Percent of Hailstone TSS Load (%)	Percent of Hailstone Total P Load (%)	Percent of Hailstone TSS Load (%)
Above Woodland	26.7	20.8	48.7	71.0	34.7	44.4
Below Woodland	49.6	54.5	34.1	15.8	56.5	17.2
Weber-	23.7	24.7	17.2	13.2	8.8	38.4

Provo
Canal

CHAPTER FIVE

PROVO RIVER THROUGH HEBER VALLEY

INTRODUCTION

The Heber Valley Sub-basin is defined as the segment of the Provo River watershed which lies between the Jordanelle Dam and the inflow to Deer Creek Reservoir. Here the Provo River flows through irrigated agricultural lands and urbanized areas. Predominant land uses are agricultural, livestock, urban and recreation.

MONITORING DATA

The 1996 JTAC sampling stations located in the Heber Valley on the Provo River and tributary streams are listed below.

Storet Number	Location
499733	Provo River below Jordanelle Dam
499725	Spring Creek at entrance to Provo River east of WWTP
591363	Provo River at McKeller Bridge above Deer Creek Reservoir
499713	Midway Fish Hatchery effluent
591016	Snake Creek above Deer Creek Reservoir at RR Crossing

Table 5.1 presents average, median, minimum and maximum values for water quality parameters monitored at each of the individual stations in 1996 within the Heber Valley. Table 5.2 presents a summary of all reported parameters from the individual sampling stations within the basin which exceed the state standard. Table 5.3 presents the data obtained from the JTAC dissolved metals sampling.

The USGS gauging station on the Provo River below Jordanelle Dam (#10155100) was discontinued during 1995. Loading calculations prior to 1995 were made using the flow rates at the USGS gauge. Therefore, In order to estimate the flow in the Provo River at the location of the monitoring station, the flows diverted into the Timpanogus Canal (upstream from the gauging station) were subtracted from the releases from Jordanelle Dam.

The Provo River

The Provo River was sampled at the upstream end of the Heber Valley (below the Jordanelle Dam) and the downstream end (above Deer Creek Reservoir at McKeller Bridge) during the 1996 water year. The site below Jordanelle Dam reflected relatively good water quality throughout the year.

At the McKeller Bridge site, the Total Phosphorus concentration reached or exceeded the 0.04 mg/l standard on 8 of 12 samples. Total phosphorus and dissolved phosphorus concentrations for these two sampling stations on the Provo River in the Heber Valley are illustrated in Figures 5.1 and 5.2. Suspended solids concentrations for both Heber Valley stations are shown in Figure 5.3.

Total phosphorus and dissolved phosphorus loadings along the Provo River for 1996 were listed in Table 4.4. The Total Phosphorus load nearly tripled between Jordanelle and Deer Creek (from 3072 kg to 8566 kg). This percent increase is slightly more than the percent increase over this stretch during 1995. This increased loading corresponds to a large increase in TSS over the same stretch, from approximately 33,000 kg to almost 2,500,000 kg. This can be attributed to the settling of suspended solids in Jordanelle and therefore a release of water essentially without sediment.

Dissolved Phosphorus for 1996 increased in the Provo River between Jordanelle and Deer Creek. The annual load increased by about 60% from approximately 2900 kg below the dam to about 4700 kg at the McKeller Bridge site. In 1994, the dissolved load increased nearly 75% over this stretch (from 1,835 kg to 3,125 kg), while in 1995 they increased by less than 10% (from 3,926 kg to 4,207 kg). Detailed loading calculations are presented in Appendix C for the 1996 water year.

The dissolved phosphorus concentrations released from Jordanelle are not easy to measure in real time. However it is hoped that a correlation can be drawn between easily measured parameters and the phosphorus concentrations such that operation of the SLOW tower can control phosphorus discharges in a reliable manner. 1996 operation of the SLOW tower watched temperature and dissolved oxygen. Phosphorus loadings discharged from the dam were relatively low. It is expected that as the operations continue more understanding will be gained.

Figures 5.4 through 5.8 illustrate the fluctuations in Phosphorus, TSS and Flow which have occurred along this stretch of the Provo River since 1980. As would be expected, high loadings generally correspond with higher flows, and higher concentrations of TSS generally correspond with higher concentrations of TP. It is important to note that there is a noticeable decreasing trend in the concentration of TSS and TP (see Figure 5.8).

Tributaries

The tributaries to the Provo River within the Heber Valley Sub-basin which were monitored during the 1996 water year include Spring Creek and Snake Creek. The Midway Fish Hatchery which discharges into Snake Creek was also monitored.

The majority of samples taken at the tributary sites were in exceedence of the JTAC total phosphorus standards. Spring Creek, Snake Creek above Deer Creek, and the Midway Fish Hatchery all had peak and average values of TP which exceeded the JTAC standards. All of the Spring Creek samples were above 0.05 mg/L, while about two thirds of the samples taken at Snake Creek and the Midway Fish Hatchery exceeded the 0.04 mg/l limit. BOD was only monitored once in 1996 at the Midway Hatchery and that result showed 18.5 mg/l which exceeds the limit of 5 mg/l.

The average total phosphorous concentrations in Snake Creek decreased from 0.08 mg/l last year, to 0.04 mg/l this year. This has been the first year since 1991 (0.035mg/L) that concentrations have decreased. Prior to 1991, the total phosphorous concentration in Snake Creek had been steadily declining (see Figure 5.10). Since 1991, total phosphorous loads have also been generally increasing as shown in Figure 5.9. However, in 1996, the low concentrations provided a reduced load when compared with 1995 even though the flow volume was greater. Hopefully, this is a long term improvement which corresponds to improved erosion control in the area. However, it will be important to continue efforts since so many of the samples were still in exceedence of the standards. (It is important to note here that no flow data for the Snake Creek site existed for 1992 and part of 1993. Flow amounts used to determine loading from Snake Creek during these periods were extrapolated from recorded flows for the Midway Fish Hatchery. These values are to be viewed as estimates only.)

About half of the 1996 total phosphorus load in Snake Creek is dissolved (1083 kg of 2005 kg). In 1996 the Midway Fish Hatchery discharged a dissolved phosphorus load (476 kg) which corresponds to approximately 45% of the dissolved load at the Snake Creek site. The total phosphorus load discharged out of the hatchery was calculated at 834 kg (see Appendix C). This load calculation does not subtract for the in-flowing load but can be used to compare with previous implementation reports.

The hatchery's UPDES requirement to limit total phosphorus (626 kg/yr) corresponds to a net increase in Snake Creek phosphorus. This allows the hatchery to subtract the in-flowing phosphorus load from their calculations. These limits took affect in April 1995. Based on monthly discharge monitoring reports submitted to the DWQ, the Midway Fish Hatchery contributed an additional 429.8 kg of phosphorus during the 1996 water year. This total increased load is in compliance with their UPDES permit.

The tributaries to this segment of the Provo River have had relatively high phosphorus concentrations in recent years. The average concentrations of total phosphorus in Spring Creek, Snake Creek, and the effluent from Midway Fish Hatchery for 1992

through 1996 are shown in Table 5.4. The concentrations of phosphorus discharged from the hatchery have been relatively consistent over the past five years. Concentrations in Snake Creek increased from 1991 to 1995, but decreased in 1996. Concentrations in Spring Creek have been very high over these five years and have even averaged 0.12 mg/l for both 1995 and 1996.

TABLE 5.4

TOTAL PHOSPHORUS CONCENTRATIONS (mg/l) IN HEBER VALLEY, 1992-1996
(arithmetic averages)

Location	1992	1993	1994	1995	1996
Spring Creek	0.08	0.108	0.08	0.12	0.12
Midway Fish Hatchery	0.051	0.065	0.052	0.05	0.043
Snake Creek above Deer Creek	0.035	0.06	0.058	0.08	0.041

CHAPTER SIX

DEER CREEK RESERVOIR BASIN

INTRODUCTION

Deer Creek Reservoir is utilized for municipal and industrial water supply, recreation, cold water fishery, and agriculture. The principal inflow is the Provo River with supplemental flows from Daniels Creek, Main Creek and several irrigation canals. During the 1996 water year, water quality samples were taken from 3 different locations on Deer Creek Reservoir and at other locations on Daniels Creek, Main Creek, the Lower Charleston Canal and on the Sagebrush - Spring Creek Canal.

MONITORING DATA

The 1996 JTAC sampling stations located on Deer Creek Reservoir and tributary streams are listed below.

Storet Number	Location
591324	Deer Creek Reservoir at the upper end
591323	Deer Creek Reservoir at Midlake
591322	Deer Creek Reservoir above the dam
591345	Deer Creek Reservoir at Wallsburg Bay
591002	Lower Charleston Canal above confluence with Daniels Creek
591352	Daniels Creek 100 feet below confluence with the LCC
591346	Main Creek at bridge on US 189 above reservoir
591027	Sage Brush-Spring Creek Canal above Daniels Creek

Quality Assurance / Quality Control was conducted on a duplicate sample taken at one of the previously listed sampling locations. This sample was labeled as the following site and then the results were compared with the data from the sample that was labeled correctly. See Appendix E of this report for a copy of the DWQ analysis of the QA / QC results.

Storet Number	Location
591349	Deer Creek West of Outhouse (QA / QC)

Table 6.1 presents average, median, minimum and maximum values for water quality parameters monitored at each of the individual stations in 1996 within the Deer Creek Reservoir Basin. Table 6.2 presents a summary of all reported parameters from the individual sampling stations within the basin which exceed the state standard. Table 6.3 presents the data obtained from the JTAC dissolved metals sampling.

DEER CREEK RESERVOIR BASIN

Deer Creek Reservoir

During the 1996 water year, water quality samples were taken during the ice free period (October 1995, and April through August 1996), at the Above Dam, Midlake and Upper End locations. Profile data on temperature, dissolved oxygen, specific conductance, redox potential and pH were also taken at these same locations. Temperature and dissolved oxygen profiles for the above dam site and the midlake site are illustrated in Figures 6.1 and 6.2. The reservoir is stratified during the months of June through September, during which time dissolved oxygen concentrations in the hypolimnion steadily diminishes.

Monitoring was also scheduled to occur on the reservoir during the months of January, February and March. However, due to the difficulties of collecting a sample while varying thicknesses of ice exist on the reservoir, these samples are seldom taken.

Monitoring was also scheduled for September. However, for whatever reason no samples were taken during that month. This may have an influence on some of the parameters calculated in this report such as the Carlson Trophic State Index.

Figure 6.3 illustrates the hypolimnetic dissolved oxygen levels in the reservoir. The depth of the Upper End site is not great enough to permit stratification to occur, which precludes the acute depletion of dissolved oxygen from occurring at the bottom. The data is typical of past years in that it manifests a steady depletion of dissolved oxygen in the hypolimnion as the year progresses, with a coinciding increase in total phosphorus levels. This is shown for the above dam site in Figure 6.4.

The Trophic State Index (TSI) for Deer Creek Reservoir was calculated the same way as for Jordanelle Reservoir. Table 6.4 shows the calculation of the TSI values for all three stations on Deer Creek. The average of all three sites was 38 which indicates an oligotrophic status. It should be noted that no samples were taken during the month of September and several of the TP samples taken on the lake surface were less than detectable which therefore places them at a zero value for the calculations. These factors may have biased the TSI value. However, the state of the reservoir is still in the mesotrophic/oligotrophic state. (Even if the zero TP values had been replaced with 10 ug/l, the TSI value would still be only about 40-41). Figure 6.5 shows the TSI values calculated for Deer Creek each year since 1981. The fifteen year trend is indicative of improving water quality. The 1994 through 1996 TSI values are the lowest (reflecting the highest quality) in the fifteen year range. The most recent decreasing trend in TSI

values is likely due to both the efforts made by Deer Creek Reservoir Restoration Project and the climatic regime of the past years which was characterized by below normal amounts of precipitation.

During the late summer months an anoxic layer develops in the hypolimnion of the reservoir. As a consequence, nutrients are released from the sediments into the water column, the fishery habitat in the reservoir is negatively impacted, and the downstream fishery in the Provo River is adversely affected. Additionally, this anoxic zone is possibly associated with the taste and odor problems which occur regularly within the reservoir. During 1996, anoxic conditions were present in the reservoir during the regular sampling events in July and August. Figure 6.6 depicts the anoxic depths in the reservoir during the months of July, August and September for the period 1986 through 1995 and the months June, July and August for 1996. This shows that the date when the hypolimnion becomes anoxic and the thickness of the anoxic zone has fluctuated slightly during the past ten years. Nonetheless, this anoxic situation is typical of the reservoir.

A monitoring probe has been located at Deer Creek Dam since March 1992 to continually monitor field parameters. Data obtained from the probe has been averaged to daily values and is shown in Figure 6.7. The annual cycles in dissolved oxygen are easily recognizable as are the temperature cycles.

Phytoplankton Floras from Deer Creek Reservoir

Annual phytoplankton studies are conducted on Deer Creek Reservoir as well as on the Jordanelle Reservoir. Samuel R. Rushforth, a Professor of Botany at Brigham Young University, has been responsible for completing these studies. A copy of this report was not available at the time of printing but a summary of the annual report documenting phytoplankton floras in both reservoirs will be included in the final version of this report.

Tributaries

The principal surface water tributaries to Deer Creek Reservoir are Daniels Creek (with the Lower Charleston Canal as a tributary), Spring/Main Creek, Snake Creek, and the Provo River. For the 1996 water year, the U.S.G.S. took daily flow measurements on the Provo River and Snake Creek. The flows for Daniels Creek and Main Creek were measured or estimated at the time of sampling. Snake Creek and the Provo River were discussed in Chapter 5.

The Sagebrush and Spring Creek Canal, the Lower Charleston Canal, Daniels Creek and Main Creek continued to have problems with high phosphorus concentrations. The average concentration for all samples at each of these locations was greater than 0.08 mg/l.

Sampling was not conducted above the Heber Valley this year. Therefore no conclusions can be made about the influence of the activities in the Heber Valley on the water quality. However, in past years, sampling has shown that most of the phosphorus is entering these streams within the Heber Valley.

Total Phosphorus loadings over the period from 1985-1996 for Daniels Creek and Main Creek are shown in Figures 6.8 and 6.9. Average Total Phosphorus concentrations for Main Creek over the period from 1985-1996 are shown in Figure 6.10.

Loadings to Deer Creek Reservoir

The 1996 total phosphorus stream flow loadings to Deer Creek Reservoir are presented in Figure 6.11. These figures are based on calculations estimating individual monthly total phosphorus and TSS loadings. The Provo River contributed 66% of the total phosphorus load while Snake Creek contributed 16%, Main Creek 10% and Daniels Creek 8%. Detailed loading calculations are presented in Appendix C.

Over 62% of the total phosphorus loading in Daniels Creek occurred in May and June. Almost 60% of the total phosphorus loading in Main Creek occurred during March, April, May and June. The loading from Snake Creek was more evenly distributed throughout the year. This would suggest that the loadings from Daniels and Main Creeks are closely associated with spring snow melt and the subsequent runoff event, whereas the loading in Snake Creek is the consequence of other influences which do not vary as much.

By combining the inflows of the Provo River, Snake Creek, Daniels Creek and Main Creek, the amount of phosphorus and TSS entering Deer Creek Reservoir can be estimated. Approximately 40% of the total phosphorus (TP) loading into Deer Creek Reservoir occurred in May, June and July. During the same period in 1995 over 70% of the total yearly load entered the reservoir.

The 1996 TSS stream flow loadings to Deer Creek Reservoir are presented in Figure 6.12. These figures are also based on calculations estimating individual monthly TSS loadings. This year the Provo River contributed 57% of the total load, while Snake Creek contributed 9%, Main Creek 21% and Daniels Creek 13%. Detailed loading calculations are presented in Appendix C.

The TSS loadings into Deer Creek Reservoir primarily occurred during spring runoff with 56% of the total yearly load entering the reservoir during May, June and July. For the same period in 1995, 93% of the total yearly load entered the reservoir.

Table 6.5 presents the comprehensive phosphorus loading budget for Deer Creek Reservoir for the water years 1995 and 1996. Calculations include all major hydrologic influences on the reservoir. No estimates have been computed for nutrient loading from the bottom sediments. A more realistic estimate of loads could be obtained if loads from the bottom sediments were available. The total inflow of water in 1996 was approximately 30% less than what occurred in 1995 and the total phosphorus load entering the reservoir was also about 30% less in 1996 than in 1995. Approximately 37% of the total phosphorus load which entered the reservoir in 1996 was retained in the reservoir. Table 6.6 and Figure 6.13 show the loading and retention which has occurred in Deer Creek during the years 1980-1996.

TABLE 6.6

DEER CREEK RESERVOIR TOTAL PHOSPHORUS AND RETENTION LOADS 1980-1996

YEAR	TOTAL P LOADING (KG)	MASS RETENTION (KG)	PERCENT (%)
1980	21933	4933	22
1981	16261	2072	13
1982	38117	4665	12
1983	43980	12239	28
1984	43796	9479	22
1985	30592	5079	17
1986	43606	7356	17
1987	17728	2609	15
1988*	14681	7103	48
1989	14899	4456	30
1990	23988	12671	53
1991	17470	7107	41
1992	9368	-2409	-26
1993	35871	22138	62
1994	11444	-1442	-13
1995	22338	12271	55
1996	16006	5871	37

* Values after 1987 are based upon flow weighted concentrations and time weighted flows.

Data for years 1980-1988 came from ***Technical Memorandum - Preliminary Retrospective Analysis of Deer Creek Phosphorous Uptake***, Dr. David W. Eckhoff to Mr. Bob Mathis, April 13, 1990.

Data from 1989 to present comes from the annual Water Quality Implementation Reports prepared by EWP Engineering.

CHAPTER SEVEN

PROVO RIVER BELOW DEER CREEK RESERVOIR

INTRODUCTION

The Provo River below Deer Creek Reservoir flows down Provo Canyon through the Uinta National Forest. Principal land use is wildlife habitat, livestock grazing and recreation.

MONITORING DATA

The 1996 JTAC sampling stations located on the Provo River below Deer Creek Reservoir and tributary streams are listed below.

Storet Number	Location
591321	Provo River below Deer Creek Reservoir
499687	Little Deer Creek above confluence with the Provo River
499685	Lower North Fork of Provo River at Wildwood
499683	Lower South Fork Provo River at Vivian Park
499681	Provo River at Olmsted Diversion
499678	Provo River at Murdock Diversion

Quality Assurance / Quality Control was conducted on a duplicate sample taken at one of the previously listed sampling locations. This sample was labeled as the following site and then the results were compared with the data from the sample that was labeled correctly. See Appendix E of this report for a copy of the DWQ analysis of the QA/QC results.

Storet Number	Location
499689	Provo River at Utah County Line - (QA/QC duplicate of Provo River below Deer Creek Reservoir)

Table 7.1 presents average, median, minimum and maximum values for water quality parameters monitored at each of the individual stations in 1996 within the Heber Valley. Table 7.2 presents a summary of all reported parameters from the individual sampling stations within the basin which exceed the state standard. Table 7.3 presents the data obtained from the JTAC dissolved metals sampling.

PROVO RIVER BELOW DEER CREEK RESERVOIR

Along the lower Provo River, water quality samples were taken from below the Dam, at the Olmsted Diversion, and at the Murdock Diversion. Dissolved oxygen (DO) levels improved in 1996 from 1995 levels. In 1996 no dissolved oxygen violations occurred at any of the stations during the sampling period.

Total phosphorus concentrations also improved in 1996 at the Below Dam Site. Only one sample taken in August exceeded the TP limit (one sample in April also reached the 0.04 mg/l standard). Total phosphorus levels and TSS concentrations for the lower Provo River are presented in Figures 7.1 and 7.2. The July and August samples taken at the Olmsted and Murdock Diversions also exceeded the phosphorus limits.

Figure 7.3 shows the average (arithmetic average) concentrations of Total Phosphorus and TSS which have occurred at the Provo River - Below Dam site during the period 1980-1996. This figure shows that TP concentrations have been decreasing since the early 1980's. TSS concentrations are also much lower than in the early 1980's.

Figure 7.4 illustrates the phosphorus loads which have been released from Deer Creek each year since 1980. Phosphorous loading at this location is closely correlated to flows. Both loads and flows decreased dramatically after 1986. Since 1987 the phosphorous loading has remained fairly constant.

Tributaries

The tributaries sampled during the 1996 water year included Little Deer Creek, North Fork of the Provo River and the South Fork of the Provo River. All of these sites experienced no exceedences during the water year.

CHAPTER EIGHT

RECOMMENDATIONS

The Provo River is one of the most important water resources in the state, and much of the Provo River watershed lies within Wasatch County. The primary purpose of the ongoing Wasatch County water quality monitoring program is to protect the water quality of the Provo River system. This chapter includes a list of either newly identified or ongoing problem areas affecting water quality and recommendations for remediation.

A. Jordanelle Reservoir - Management of Releases

The completed filling of Jordanelle Dam has allowed the reservoir to move into a fully operational condition. The trapping efficiency of suspended sediments and total phosphorus is apparent. The Selective Level Outlet Works (SLOW) at the Jordanelle Dam was operational for most of 1996 and the preliminary results indicate that not only did it help to manage the temperature and Dissolve Oxygen levels, but it may have also contributed to the reduction in Phosphorus levels discharged as well. The Bureau of Reclamation is currently developing a management plan for operation of the SLOW to maximize benefits to all parties.

JTAC should work towards helping to develop an Operating Plan which allows for the distribution of required water rights, but also provides the necessary type of releases to control or improve the water quality in both reservoirs.

B. Kamas Fish Hatchery - Dissolved Phosphorus Discharge

Kamas Fish Hatchery continues to consistently have high concentrations of total phosphorus (mostly dissolved) in its effluent, but the annual loads are relatively small because the hatchery is a small operation. No phosphorus limits have been set for the hatchery by the DWQ in their UPDES Permit for the facility. The Division of Wildlife Resources is currently planning to rebuild the Kamas Fish Hatchery. JTAC should urge the DWR to incorporate design features in the new hatchery to minimize phosphorus and other contaminants from being discharged. Furthermore, JTAC should evaluate the conditions associated with the discharges from this hatchery and the diversions from Beaver Creek to determine the extent to which the Kamas Fish Hatchery discharges affect the Provo River system. (See Chapter 2 page 2-5 and Chapter 4 page 4-3 for more details)

C. Heber Valley - Storm Water Controls

Phosphorus concentrations in the tributaries and canals of Heber Valley continue to be consistently above the JTAC standard. The watercourses of greatest concern are Spring Creek, Lake Creek, Snake Creek, Daniel's Creek, Sagebrush Canal, and the Lower Charleston Canal. Even though many of these creeks or canals have ties to irrigation uses, a significant portion of the sediment phosphorus and TSS is directly related to storm water runoff.

With increasing urbanization in Wasatch County, storm water runoff is expected to continue to be a significant source of pollution. Additionally, with the planning and design of the Daniel's Replacement Project and the CUP Efficiency Study many existing canals will be abandoned. These canals could act as conduits for highly concentrated storm water to enter Deer Creek.

The first phase of the Storm water Management Plan is being developed as part of the FY 1997 JTAC work. Completion of the plan and implementation of the recommendations will be critical to controlling storm water in the Heber Valley. Some initial projects to reduce storm water sediment loadings may be as simple as construction of sediment ponds at the end of the existing canals prior to discharging into the receiving stream.

D. Upper Provo River - Non-Point Erosion

Non-point source loadings of total phosphorus and total suspended solids are substantial in the reach of the Provo River between Woodland and Hailstone. These loadings will now have a more pronounced effect on the water quality of Jordanelle Reservoir. Following completion of the Tri-Valley Watershed soil erosion study, the NRCS conducted field inventories of the area to further locate possible sources of these loadings. Some farming and grazing practices in this area that could be contributing to the problem were identified. Some properties which showed efforts had been implemented to minimize erosion were also identified. The NRCS plans to publish the draft report of their resource studies in 1997. JTAC should continue efforts to coordinate with the Tri-Valley Watershed Program, provide comments for the resource studies, and support efforts to implement best management practices and erosion control measures in the area. (See Chapter 2, page 2-7 and Chapter 4 page 4-2 for more details)

E. Main Creek - Total Phosphorus Concentrations and Loads

Figure 6.10 showed that average phosphorus concentrations in Main Creek have been consistently above the JTAC standard over the past ten years (some years have been significantly above standard). The NRCS through the Tri-Valley Watershed studies has looked at specific water quality improvements that can be implemented along this stream. JTAC should work with the Natural Resources Conservation Service to help the Tri-Valley Watershed Plan move forward and to implement

appropriate measures.

F. Groundwater Monitoring

In 1995, Wasatch County received classification of the aquifer in Heber Valley in order to protect its water quality. Ordinances are being enforced to require new developments with densities greater than one residence per five acres to provide sewer services. After all of the effort which has and continues to be placed toward protecting the groundwater, it is recommended that JTAC work with the County to develop a groundwater monitoring plan to help detect any existing or future problems and define trends in the groundwater. This effort can be started by corrolating the available data from existing wells in the valley.

G. Water Quality Management Plan

A new water quality management plan for Wasatch County was started in 1995. This is intended to assist with management of the water resources throughout the watersheds for Jordanelle and Deer Creek. This plan will identify the Total Maximum Daily Loads that the Provo River system can handle. The system as a whole has been separated into individual stream segments and TMDLs for each segment are being computed. TMDL's have been computed using different standard flow scenarios to determine the most appropriate limits for this water system. Once appropriate TMDLs are accepted, new long range goals and objectives for the watershed can be developed.

JTAC should continue to work with Wasatch County to implement management strategies which will improve water quality in the Provo River System.

H. Midway Fish Hatchery - Dissolved Phosphorus Discharge

Phosphorus has been included in the UPDES Permits for the Midway Fish Hatchery since 1995. A significant effort to minimize the phosphorus discharge has been noticeable in 1995 and 1996 as the total phosphorus discharge has been approximately 25% less during these two years.

However, with increasing demand on the hatchery, phosphorus control efforts will continue to be important to insure that the UPDES limits can be met. JTAC should continue to work with the Division of Wildlife Resources to see that adequate resources are allocated to Midway Fish Hatchery for maintenance on the ponds and other efforts to control phosphorus discharges.

I. Winter Reservoir Monitoring

Monitoring is usually scheduled to occur on both Deer Creek and Jordanelle Reservoirs during the months of January, February and March. However, due to the

difficulties of collecting a sample while varying thicknesses of ice exist on the reservoir, these samples are seldom taken. If a method could be determined to safely take these samples, the winter time data could be important to analyze and monitor over the years.

JTAC should work with the agency which is assigned to perform this monitoring and investigate options which may allow for collection of the data during all scheduled periods.

J. Deer Creek Reservoir - Feasibility Study for Aeration and De-stratification

Deer Creek Reservoir continues to exhibit an anoxic zone within the hypolimnion during the late summer/fall months. Figure 6.7 showed the regular cycles of anoxic discharges which occur. Anoxic periods are relatively short (a few months each year). The technology to aerate the reservoir just above the dam, and eliminate the anoxic zone does exist. Potential benefits of aeration include: (1) slowing or reversing the eutrophication process through reduction of soluble phosphorous levels in the water column; (2) reducing blue green algae blooms; (3) reduced taste and odor problems; and (4) elimination of downstream fishery concerns associated with seasonal releases of oxygen-depleted waters from the dam.

It is recommended that a preliminary feasibility study be conducted using the Deer Creek Reservoir Model to assess the impact of aeration on the water quality in the hypolimnion of the reservoir. If the model projects positive benefits, a more in depth study should be undertaken to assess the feasibility of, and quantify the benefits which could be derived from, hypolimnetic aeration of the reservoir. We believe that costs would be minimal in relation to the results which would be immediately apparent.

K. Revised Provo River Monitoring Schedule

Jordanelle has the greatest potential to release high DTP concentrations and loads from late August through November. After Heber Valley irrigation diversions stop in September, the full phosphorus load will be conveyed to the Deer Creek Reservoir. Deer Creek has the greatest potential to respond with blue-green algae blooms from mid September to mid November depending on temperatures. Therefore, with the Jordanelle Dam in operation greater emphasis needs to be placed on nutrient and plankton monitoring in the Provo River, Jordanelle and Deer Creek Reservoirs in September, October, and November. This may require dropping a sampling period in June or July. Greater sampling emphasis is needed from August to October to better determine the best operating procedures for the Jordanelle SLOW tower to produce the greatest benefit to Deer Creek Reservoir.

L. Lower Provo River - Below Deer Creek Dam

Water quality issues for this section of the Provo River are being coordinated by the Provo River Technical Advisory Committee (PROTAC). These activities are being administered by Ray Lovless of the Mountainlands Association of Governments.

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